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PROCEEDINGS OF THE CRAWFISH AND CATFISH AQUACULTURE CONFERENCE

July 28, 1984

Charleston, South Carolina

Compiled by
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PREFACE

In July, 1984, a seminar on the Crawfish and Catfish Aquaculture was convened at Charleston, South Carolina. The meeting was sponsored by the South Carolina Wildlife and Marine Resources Department and the South Carolina Sea Grant Consortium. The main objectives of this seminar were to improve knowledge of crawfish and catfish growers in production and marketing management and to share knowledge of fish farming with prospective aquaculturists.

There has been a rapid growth of interest in aquaculture in South Carolina. This meeting reflected a perceived need to provide education, research and advisory activities to assist aquaculture development in South Carolina. The proceedings of this meeting represent part of the cooperative effort of public agencies to provide production, marketing and management information for crawfish and catfish operations. This publication was compiled from copy prepared and submitted by the invited speakers and the panel members. Funds for publishing this document were provided by the seminar sponsors. Reference to trade names in this report does not imply endorsement by the State of South Carolina or NOAA Office of Sea Grant.

A special thanks goes to Dr. Paul Sandifer, who gave the opening remarks and provided support for the project. Special thanks are due to the invited speakers and the panel members for their contributions and to Dr. Richard Johnston for his assistance. Mrs. Nancy Peacock provided assistance for the meeting and Mrs. Catherine deLiesseline typed the manuscript.

David S. Liao

INVITED PAPERS

LIFE CYCLE OF CRAWFISH AND COMMERCIAL PRACTICES

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Commercial culture of crawfish is practiced worldwide, but the majority of the culture takes place in Southeastern United States with Louisiana, far and away, the leader in crawfish culture.

Two species are cultured in the Southeast, the red swamp crawfish (*Procambarus clarkii*) and the white river crawfish (*Procambarus acutus acutus*). In normal cultural situations red swamp crawfish compose 80% of the population, but this is not a hard and fast rule. Some farms have white river crawfish in abundance. Red swamp and white river crawfish have very similar habits and life cycles so from here on

"crawfish" will be used to apply to both species.

Biology

Crawfish habits give them an excellent potential as a culture species. Crawfish are fairly tolerant of poor water quality parameters, are low on the food chain, reproduce rapidly, have a large number of young, and grow to marketable size rapidly under good conditions.

Breeding occurs in open water and peaks between May and June in South Carolina. Sperm is retained by females until eggs are laid in September. The reproductive cycle is controlled by flooding and draining; therefore, the cycle used in culture mimics natural swamp conditions.

Crawfish burrow into the pond bottom as water is drained. Burrows are usually 1-1/2 to 3 inches in diameter and form a pocket at the groundwater table.

Eggs are laid in late August through September and are held in place on the underside of the female's tail. Each female lays between 400-700 eggs, and eggs hatch in two to three weeks. Upon hatching the young stay under the female's tail for two or three weeks until flooding occurs in the fall.

Crawfish are omnivorous and feed on living and decaying plant and animal matter. The decaying plant matter with its associated microscopic plant and animal community make up the majority of a crawfish's food.

Crawfish are arthropods that possess rigid exoskeleton between molts. Growth occurs as crawfish molt or shed their exoskeleton and absorb water rapidly then reharden in a period of three to four hours. Growth rate is dependent on food and temperature.

Site Selection and Pond Construction

Two major parameters, soil and water, need to be considered for proper site selection for crawfish culture. Soil must be able to hold water and, in turn, be drainable. The soil composition needs to be 30% clay. Areas with clays, silty clays and sandy clays have potential. In many areas a shallow surface area of sand can be removed to reach clay strata, or the clay area may be very narrow and give problems. The sites should be individually checked with a soil auger. The United States Soil Conservation Service technical assistance can be of great benefit.

Proper soil chemistry is important, but can be adapted in certain situations just as in agricultural practices. Optimum soil pH is between 6.7-7.0 and can range from 6.0-8.0. Calcium levels are also important for good growth, and lime applications are recommended.

Since crawfish are aquatic animals water is an important limiting factor. Both water quantity and quality need to be of proper limits for good production.

Water quantity must be enough to maintain evaporative and seepage losses and still regulate dissolved oxygen. A general rule is water must be furnished at a rate of 100 gallons per minute per acre.

Water quality should reach the following levels; greater than 3.0 parts per million (ppm) dissolved oxygen, greater than 50 ppm total hardness (200 ppm is optimum) and pH from 5.8-8.5 (6.5-7.0 is optimum). Salinities for crawfish must be five to six parts per thousand or less for successful reproduction.

Water sources can be either groundwater (springs and wells) or surface water (streams and reservoirs). Groundwater is pollution free and has a constant temperature; but is often soft and low in dissolved oxygen. Pumping is also required. Surface water has lower pumping costs and higher pH and hardness, but pollutants and predators are disadvantages.

Ponds are best constructed in fairly flat areas with little slope. After construction pond bottom slope should be 0.3 to 0.6% for good drainage. Outside dike widths should be large enough for vehicular traffic. Water circulation is extremely important to maintain dissolved oxygen above three ppm over the entire pond. Circulation levees, built with a levee plow, should be constructed so that water will be changed every three to four days.

Pond sizes from 10 to 20 acres appear to be the best units from construction costs and production standpoints. Therefore rice fields offer good production unit alternatives.

Pond depth in crawfish ponds varies between 12 and 36 inches with 18 inches the optimum depth. Depth is important for forage, water quality maintenance and harvesting efficiency.

Stocking

Adult crawfish are stocked at a rate of 50 to 75 pounds per acre, depending on the vegetation present in flooded ponds in May to June 15. June 15 is the cut off date for stocking because higher summer temperatures above 90°F cause mortality, and reduce reproduction for next spring's harvest and forage establishment problems. Broodstock crawfish should be sexually mature and 13 to 17 should equal one pound. Sex ratio is important and should be at least 50% male, 50% female with 60-70% female makeup the optimum.

Restocking is usually not necessary unless stunting has occurred, or a reproductive class is lost due to water quality problems. If some restocking is needed 20 to 25 pounds of adult crawfish per acre can be added.

Water Management

Proper water management is the limiting factor in good crawfish production.

The life cycle of crawfish is dependent on a specific water management scheme, and the maintenance of good water quality is of primary concern for maximum crawfish production.

Several general water management schemes are utilized in producing crawfish in combination with agricultural crops, but only one scheme is utilized in a traditional crawfish culture cycle.

Rice-Crawfish-Rice Rotation

April	Plant rice
May-June	Stock Crawfish (2nd.flood)
August	Drain, harvest rice
September-October	Reflood stubble
November-April	Harvest crawfish
April	Plant rice

Permanent Crawfish Pond Management

April	Fill pond-Predator control
May-June	Stock crawfish
June	Slowly drain pond
June-July	Plant vegetation
September-October	Reflood pond
November-June	Harvest crawfish

Dissolved oxygen and temperature are the most important water quality parameters in crawfish production. Dissolved oxygen can be a major problem due to the depth of water and the decay of organic matter at flooding. Water must be aerated or recirculated for maximum production. Temperature influences crawfish activity and therefore influences harvesting. Growth is inhibited between 50-55°F; activity and trapping starts at 65°F and crawfish activity doubles with each five degree increase in temperature; best growth is between 70-80°F; and growth and survival are inhibited above 90°F.

Forage Establishment

If proper forage for crawfish is established crawfish usually do not need any further artificial feed. Forage types need (1) to decay over a period of time instead of immediately after flooding, thus causing dissolved oxygen problems; (2) to remain standing in water; and (3) to furnish enough vegetation for good crawfish production.

Three alternatives exist for crawfish forage. Domestic rice can be planted; natural aquatics can be managed for; or a combination of the planted and natural foods can be used.

Untreated Melrose or Mars varieties or commercial rice stubble after harvesting can be used for forage. In a pond managed specifically for crawfish 100 to 150 pounds of Melrose or Mars variety rice is planted per acre between June 15 and July 15. The rice can either be wet or dry seeded according to the pond conditions. In dry seeding, seed is drilled one to two inches in a dry, weed-free seed bed. In wet seeding, seeds are soaked for 24 hours prior to broadcasting onto a moist seedbed then field is drained after germination for the successful rice to emerge.

Rice has been found to be the best domestic crop for crawfish because of its decaying capacity, its resistance to lodging and its forage makeup.

Some farmers manage strictly for natural aquatic vegetation. Production costs are reduced since rice is not planted, but crawfish production is reduced. The major types of aquatic vegetation are alligatorweed, smartweed and water primrose.

The best production in crawfish ponds is obtained from a combination rice-natural aquatic vegetation management. Rice acts as a forage crop until mid spring then natural aquatics take over until ponds are drawn down in summer.

Harvesting

Harvesting of crawfish is labor intensive and represents the highest expense of crawfish production annual costs. Crawfish are harvested by trapping. Traps are

constructed of three-quarter inch poultry wire which is usually plastic coated to give longer trap life. Funnels are formed in the bottom of traps and can number from one to four funnels per trap. Most farmers use two funnels. Traps are baited with either artificial bait, made of fish meal and oil and flour from various agricultural products; or natural baits such as gizzard shad, beef melt, menhaden or herring. Traps are run daily from November to June when water temperatures exceed 65°F and may be run twice daily as water temperatures exceed 75°F.

Generally crawfish are not graded. The mesh size of the trap has been used to distinguish harvestable size.

Crawfish traps are collected by hand, and the means of boat propulsion, if necessary, is dependent upon pond size, labor available and equipment costs.

Production Yields

Crawfish production varies with pond type, water quality, forage and trapping intensity. Yields the first year tend to run 50% lower than succeeding years. The following yields are for established ponds under Permanent Crawfish Management with a forage crop planted in South Carolina.

<u>Pond Type</u>	<u>Pounds/Acre</u>
Upland (Open-cultivated)	1,000-1,200
Upland (Wooded)	600-800
Marsh (Open-cultivated)	600-800
Marsh (Wooded)	400-600

Production

<u>Type</u>	<u>Cost</u>	<u>Traps Harvested</u>	<u>Time</u>	<u>Labor</u>
Walking	--	300-400	1 day	1 man
Go-Devil	\$1,500-3,000	200-300	1 hour	2 men
Rear-Drive Go-Devil	1,500-3,000	200-300	1 hour	1 man
Combine	2,500-5,500	200-250	1 hour	1 man
Four-Wheel Drive	\$6,000	200-250	1 hour	1 man

MARKETING AND EXPANSION POTENTIAL OF THE SOUTH CAROLINA CRAWFISH INDUSTRY

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In 1984, there were 537 hectares of crawfish ponds in South Carolina as compared to only 14 acres in 1976. Due to this rapid expansion and the growing economic importance to the farm sector, information is needed concerning market outlets for crawfish. In addition, the profitability of crawfish farming is influenced by the market alternatives and prices. There are a number of market outlets and growers will need to determine which one is best suited for their operation. This paper examines (1) direct sale markets, restaurants, wholesale and retail markets in South Carolina; (2) wholesale and retail markets located out-of-state; and (3) programs for expanding the South Carolina crawfish industry.

South Carolina Market Outlets for Crawfish

During 1983, a survey of crawfish consumers was conducted to evaluate direct

sale to consumer markets in South Carolina. Consumer questionnaires were provided to the producers for distribution to their customers. Fourteen completed questionnaires were received. About 100 questionnaires were distributed to consumers who purchased boiled crawfish at the South Carolina Crawfish Festival. Twenty questionnaires were returned and analyzed for this study.

Consumers were asked to evaluate the product in terms of freshness, texture, taste, ease of preparation and price. The majority of consumers who purchased live crawfish from producers rated the product as excellent in freshness, texture and taste (Table 1). About 28% of the consumers indicated a fair or poor rating on price. Among those consumers who purchased boiled crawfish, about 55% rated the freshness of the product as excellent and 39% rate the product as excellent in texture and taste (Table 2).

When consumers were asked whether they would purchase crawfish again for home consumption, about 74% responded positively. About 26% indicated that the product had too little meat, or was difficult to open, or too high in price. The frequency of consumers' intent to purchase crawfish again for home consumption during the harvesting season was as follows: 9% would purchase crawfish at least once per week; 45.5% would purchase twice per month; 18.2% would purchase one per

Table 1. Evaluation of crawfish based on home preparation by consumers (N=14). Results are expressed as percentages (%).

Rating	EVALUATION CATEGORIES				
	Freshness	Texture	Taste	Ease of Preparation	Price
Poor	0	0	0	0	14
Fair	0	0	0	14	14
Satisfactory	14	0	0	0	29
Very Good	29	43	29	57	0
Excellent	57	57	71	29	43

Table 2. Evaluation of crawfish based on non-home preparation by consumers (N=20). Results are expressed as percentages (%).

Rating	EVALUATION CATEGORIES				
	Freshness	Texture	Taste	Ease of Preparation	Price
Poor	0	6	11	12	12
Fair	0	0	6	19	19
Satisfactory	6	11	22	22	38
Very Good	39	44	22	31	12
Excellent	55	39	39	19	19

month; and 27.3% would purchase less than once a month.

Consumers paid an average of \$1.50/lb for live crawfish and average quantity purchased per household was 12.8 lbs. The average quantity purchased at the price of \$1.25 was 15.8 lbs. per household; however, if the price were increased to \$1.75, the quantity purchased would be 10.5 lbs. per household. This indicates that a given increase in price causes a relatively larger decrease in the amount of live crawfish purchased. Thus, an increase in price would not raise income for the producer under the existing market demand situation. In order to increase gross income from crawfish farming, an increase in demand for the product is needed.

About 72% of the consumers indicated a preference for the product in live form. About 40% preferred to buy only the cooked tail meat. This indicates that crawfish could be marketed in this product form. At the present, there is no crawfish processing facility in South Carolina to supply a cooked tail meat product.

Most producers sold their live crawfish directly to consumers. This market outlet appears most attractive for small-scale producers. However, it may not be suitable in situations where production is high or where the farm is isolated. Seafood restaurants and retailers may be more suitable for large scale producers.

In November 1983, a survey of market outlets in selected South Carolina seafood restaurants, wholesale and retail, were conducted by Will Lacey and David Liao. Fifty-seven out of 157 survey forms mailed were returned.

Ten out of the 54 businesses responding indicated that they handled crawfish in their establishments (Table 3). The largest number (6) came from the restaurant categories. No wholesalers reported carrying any crawfish and only four retailers indicated any experience with them. About 38 South Carolina businesses reported an interest in purchasing crawfish (Table 4). This represents a 74.5% positive response rate. The greatest number came from the restaurant component while wholesale was second and retail was third.

Out-Of-State Market Outlets for Crawfish

In 1983, a survey of out-of-state market channels was also conducted. The questionnaires were mailed to 171 wholesale and retail companies selected for the survey. Thirty-nine completed questionnaire were received from the survey.

Out-of-state respondents showed a favorable interest in buying crawfish. About 85.7% of the wholesale/retail group answered in a positive manner. Many out-of-state companies indicated an interest in purchasing more than one product form. (Table 5). Eleven out of 22 would purchase live, nine would buy seasoned fresh or frozen boiled, eight would purchase fresh tail meat and 12 would purchase frozen tailmeat. To supply all product forms preferred by out-of-state companies, a processing facility is needed. Thus, lack of crawfish processing facilities in South Carolina would restrict marketing opportunities for South Carolina crawfish in out-of-state markets.

Table 3. Number of South Carolina Seafood businesses handling crawfish, 1983.

	Restaurants	Wholesale	Retail	Total
Yes	6	0	4	10
No	24	10	10	44
Total Responses	30	10	14	54

Table 4. Number of South Carolina seafood businesses interested in purchasing crawfish, 1983.

	Restaurants	Wholesale	Retail	Total
Yes	22	10	6	38
No	5	2	6	13
Total Responses	27	12	12	51

Table 5. Product form preferred by out-of-state seafood wholesalers and retailers, 1983.

Product Form	Number ^a	Percent
Live	11	50.0
Seasoned Fresh Boiled	9	41.0
Seasoned Frozen Boiled	9	41.0
Fresh Tailmeat	8	36.4
Frozen Tailmeat	12	54.5
Total Responses	22	

^a Some respondents indicated their preference for two or more product forms.

Programs for Expanding the S.C. Crawfish Industry

1. Consumer Education and Product Promotion Programs.

Product promotion programs such as advertisements, cooking demonstrations, quality control and consumer education will all result in an increased consumption of crawfish.

2. Cooperative Marketing Program.

This program will improve market position of small-scale producers in bargaining for prices and marketing services with wholesalers. It will reduce marketing costs for crawfish producers.

3. Biological and Economic Research.

Biological and economic research are needed to improve existing crawfish aquaculture technologies in South Carolina. Research on pond management, water quality, predator control, growth rate, artificial and natural baits and costs of production and marketing may increase production and profitability for farmers.

4. Aquaculture Credit Program.

Crawfish aquaculture is a relatively new industry; therefore, the risk of investing in such aquaculture is high, according to commercial financial institutions. The commercial bank is often reluctant to extend credit to small-scale producers. Government supported credit programs at reasonable interest rates could expand the South Carolina crawfish industry.

ECONOMIC AND MARKETING TRENDS IN CRAWFISH-FARMING BUSINESS IN LOUISIANA

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Louisiana has a very large natural crawfish fishery, producing millions of pounds annually. Two or three consecutive years supplies from natural wild crop (swamps and the Atchafalaya Basin) have been high. In 1983, Louisiana produced about 70 million pounds of crawfish. Prices have gone down three years in a row but the State still has 100,000 acres under cultivation. Crawfish farming is on the increase, and efficient pond management can greatly improve its yield. These trends for crawfish in Louisiana has prompted the industry to review their production costs. In September 1983, the members of the Louisiana Crawfish Farmers' Association and the Louisiana State University Extension Service personnel developed a range of crawfish production costs to reflect various types of operations. All figures developed represent an annual cost per acre based on a 40 acre pond. The figures have not changed much since that time.

PRODUCTION COSTS

Capital Expenses

The production costs were grouped into capital and operating expenses. Capital or overhead costs since they occur at the start up of an operation had to be put on an annual basis over the life of the item or pond. Among these items were pond construction, water supply and control units, oxygen waters, harvesting boats and aeration systems. These expenses can be put on an annual basis through depreciation and

capitalizing. There are three levels of investment; low, medium and high. The low investment level reflects people in the business who are already in agriculture who have money, who have existing farm equipment and have some farm land. The high investment would be basically doing things in terms of 40-acres units. The levee and water control units would be contracted, i.e. turn key contracts. A well of 12 inches is assumed to reflect the more costly method of acquiring suitable water. If a farmer buys everything brand new, that's high level. The medium investment level is something in between. Surface water is used with an electric powered pump. The capital expenses at three assumed levels is portrayed in Table 1. The investments have been annualized by item and level. The vast majority of our people in the business in terms of acreage are in the low investment side. Pond construction would be minimal per acre, that is \$12.00 per acre annualized. Again, somebody who is in the rice farm business or the sugar cane business will have capital to drain water away from their crop instead of holding it. Thus, water control is a very small additional investment. The pond construction on the low investment would be something like a four foot top, with a small rice field levee or drainage levee from a sugar cane field. The high investment would be something like a 14 foot top. The pumps and the power units are a good sized investment.

The harvesting unit, "Why is it so low?", in column one compared to three. Basically, the low unit involves walking or some sort of outboard powered boat. The medium would be something like a john boat with go-devil on it. If the producer has 40 or 50 acres in the crawfish business, the hydraulic powered harvester is recommended because there is a direct relationship between how productive crawfish pond will be with this equipment as opposed to walking or an outboard. The hydraulic powered system for about \$6,000 is well worth it.

Table 1. Estimated Annual Capital Expenses and Operating expenses per acre for 40 acre pond by investment level.

Item	Annual costs per acre by investment		
	Low	Medium	High
Capital Expenses			
Pond construction	\$ 12	\$ 36	\$ 45
Pumps & power units	30	48	114
Oxygen meter	1	2	5
Harvesting unit	5	24	43
Aerators & Misc.	70	123	164
Subtotal	\$118	\$233	\$371
Operating Expenses			
Pre-harvest	\$ 46	\$ 64	\$124
Harvest season	127	420	1,167
Subtotal	\$172	\$484	\$1,291
Total Expenses	\$290	\$717	\$1,662

Aerators and miscellaneous costs as a category is a big item because they also include trucks, traps, coolers, etc. The annualized capital cost was \$118 per acre on the low investment system, \$233 per acre on the medium investment system, and \$371 per acre on the high investment system.

Operating Expenses

These are the frequent and visible out-of-pocket expenses which generally occur both prior to harvest and during harvest. The pre-harvest costs included pumping for water quality management, feed establishment, trap placement, labor and others. The low level of pre-harvest cost is based on the use of natural grass and aquatics as the food source. There is only some labor cost involved at this level. Labor is used to trim grass and flood the pond. There is some labor cost associated with trap placement. The initial flood (pump-up) of the pond may require pumping. Oxygen demand will be high as the grass crop falls into the water and begins to decompose. There is no cost in the low estimate for grass or food source establishment whereby in the others there is. Harvest season costs included bait, labor, fuel, repairs, etc. Harvest season expenses, the difference between the low and the high relates primarily to the degree of trap density. The low column assumes somewhere around 20 traps per acre. The high column assumes about 30 traps per acre. The high level would mean the producer would run traps occasionally twice a day when the market prices dictate. The other levels assume one trap run daily.

Total production costs is presented in the bottom line of Table 1. Total costs were about \$290 per acre on the low cost system, \$717 per acre on the medium cost system and \$1662 per acre on the high cost system. It should be noted that a low cost system may not produce the desired yield each year. Also the high cost method of doing things does not necessarily mean that ponds will produce high yield of crawfish. The high cost system does mean however, that it better be managed to produce high yields each year to pay for itself.

Break-even Price and Production

Break-even price is the price received per pound necessary to pay all capital and operating expenses, given some poundage produced. Break-even price is presented in Table 2, given production level per acre in 40 acres for each of these investment levels: low, medium and high costs. At 500 per acre, 1,000 or 1,500 pounds per acre, break-even price was about \$.58 a pound to the ridiculously high \$3.32 per pound. This indicates that if the producer is going to have a turn key operation and invest a great deal of money, the producer can not make it in Louisiana even at around 1,500 pounds per acre. If the price of crawfish were \$.50 per pound, it would take about 990 pounds to break-even. Louisiana crawfish ponds produced an average annual yield of 500 - 1,000 pounds per acre. The highest yield was about \$2250 pounds per acre. If crawfish ponds are not producing 800 pounds per acre, it is not economically interesting. Ponds have to produce at least that to make it worthwhile.

Marketing Trends

Three years ago, crawfish price was \$.66 per pound, went to about \$.54 per pound, then to \$.47 per pound and to \$.42 per pound. However, the industry has been expanding every year. This indicates what kind of profits there must have been in the industry when price was around \$.66 per pound. Crawfish producer's are expecting to get it back in terms of higher prices when a natural crop has low yield. Crawfish farmers are gambling on the nature system producing at high yields two out of five years.

There was variation in farm level crawfish prices even within Louisiana. In 1984, the traditional crawfish area averaged \$.42 per pound while in north Louisiana averaged \$.60 per pound. This variation was due to problems in shipping live crawfish. At present, no research has been conducted to solve long distance packaging or transportation problems for shipping live crawfish. To ship live crawfish from Louisiana to South Carolina, producers would

Table 2. Estimated break-even price, given production level per acre in 40 acre pond by investment level.

Production level per acre in pounds	<u>Break-even price in \$/lb. by investment level</u>		
	Low	Medium	High
500	\$.58	\$1.43	\$3.32
1,000	.29	\$.72	\$1.66
1,500	.19	\$.48	\$1.11

have to run their crawfish again when they arrive, in other words, burst the sack, float the dead ones out of the tank and repackage it prior to sale. That would be a costly operation both in terms of labor and also sorting out the mortality. Thus, crawfish producers in South Carolina do not need to fear the competition of crawfish from Louisiana. Prices of live crawfish in South Carolina, within the next 5 years should be preserved.

MANAGEMENT AND SELECTION OF BROODSTOCK AND PRODUCTION OF FINGERLING CHANNEL CATFISH

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Brood Fish Selection and Management

Just as cattle or hog producers realize that the quantity and quality of young animals produced is directly related to the selection and management of brood animals, so must fish farm operators or hatcherymen. Many producers of catfish have neglected their brood animals. They have failed to select quality animals, maintain proper sex ratios, provide adequate nutrients for egg development, cull older stock and make quality replacements. Efficient operators that produce quality fingerlings in large quantity on an annual basis use good management and good stock to do it. The aim of this paper is to discuss different methods for selection and management of spawners and to suggest methods used to produce quality fingerlings of adequate or desired quantity.

Spawning in Nature

In a natural setting, channel catfish migrate to the shallow water areas of rivers and lakes to spawn. At this latitude, spawning takes place between April and August. After arrival at the spawning grounds, males fight to establish territories. Males seek out suitable areas for spawning where they will construct a crude nest by sweeping away mud and other detritus. After the site is prepared, the male fish entices the female fish in to spawn. If the female is in any way reluctant, the male drives her away. If she is ready to spawn, they begin courtship and subsequently begin to spawn. Spawning may last several hours. As the act is completed, the male fish drives the female away, and he, alone, vigorously guards and aerates the egg mass until hatching occurs.

Selection of Brood Animals

Successful hatcherymen select spawners with a critical eye. Sexually mature fish are selected during fall or early spring on the basis of age, relative size, sexual development, body conformation and ancestry.

Fish that are at least three years old are usually selected. Spawners should be three pounds at least and range up to 10 pounds and are generally culled after 12 pounds. Sexual development in brood animals is most important. Even though fish may be large and of proper age, they may exhibit poor sexual development. Quality spawners have good coloration and pronounced genital development. Females have distended abdomens while males have broad, muscular heads, pronounced genital papillae and dark pigmentation underneath the body. Body conformation or shape is important for consideration. Spawners should be deep bodied and thick as possible. Length is not of major importance as fish are sold by weight, not length.

There are some pertinent points that might be considered in an effort to insure that most productive spawners.

Avoid Inbreeding

Since current practices are to keep brood animals for 4 to 10 years and with replacement coming from progeny produced on the farm, some amount of inbreeding is inevitable. Further, the beginning operator may have started with full brothers or sisters, thus he may have a very narrow genetic base at the onset. Inbreeding depression has been well documented in trout and carp. Both of these fish show severe growth depression and lack of general viability and resistance to disease due to inbreeding. Any hatcheryman can avoid inbreeding by considering and applying one or more of the following methods.

a. Enrich Bloodlines - Addition of unrelated stock has been shown to be effective in correcting deterioration of quality in brood animals and progeny. The need to enrich bloodlines may be expected if a high percentage of fingerling deformities or abnormalities are observed, if egg massive hatch poorly, or if poor fry survival and poor food fish growth are noted.

b. Crossbreed Unrelated Stocks - Spawners from different ancestries produce progeny that are very different. These unrelated stocks can be crossbred to take advantage of "outcrossing" vigor, especially in resistance to disease and ability to gain weight. If your stock are producing progeny that seem especially susceptible to disease or grow poorly, crossbreeding should be considered.

The breeder can maintain stocks of different strains easily. The fish can be branded or otherwise marked and stocked together or if pond space is available, they can be stocked in separate ponds. One approach that is often used is to keep males of one strain and females of another.

Conditioning Spawners

Sexually mature female catfish begin production of eggs in late July and August and continue until cold weather. They resume development in mid-February and continue until spawning. In order to have spawners ready for the rigors of the mating season, a time when they may not feed for two months, they need adequate quality and quantity of food at the proper times. Successful operators begin feeding their brood stock soon after spawning. Brooding fish usually consume one to two percent of body weight daily during warm weather, but their appetite tapers off with the onset of cool weather, and increases as winter weather breaks and water begins to warm. Brood animals do well on commercially prepared feeds if they are allowed the proper quantity. Most operators feed their broodfish daily (one to two percent body weight) along with their fingerlings and food fish. Many farmers provide additional nutrients in the form of forage fish such as carp (small), gold fish, shiners, tilapia, etc. Others feed their spawners with chopped or cut fish (shad, carp, gold fish) one to two times weekly, especially during fall and spring.

Spawning in Captivity

The three types of spawning practiced in channel catfish culture, in decreasing order of similarity to natural spawning, are pond or "wild" spawning, pen spawning and aquarium spawning. Most culturists practice pond spawning because it requires minimal facilities, least time, labor and skill.

Pond Spawning

Spawning ponds for channel catfish range from 1-20 acres in size, but most farmers agree that 5-10 acre ponds are most desirable. Pond depth may vary from two to eight feet but should average three to four feet. Ideally, spawning ponds should be dry during winter months and should be filled 30-40 days prior to spawning time. Triple superphosphate is successful in stimulating a plankton bloom when applied at 30-60 lbs. per acre at two week intervals. The green bloom will discourage growth of marginal or emergent aquatic plants.

Brood fish are stocked two to three weeks prior to spawning usually mid-April. Brooders are stocked at 50-300 fish per acre. Of course, if eggs are to be removed and artificially incubated, greater number (pounds) of broodfish may be stocked per acre. Generally, 800-1200 pounds per acre are the upper limits to stock spawning ponds. Equal sex ratios are usually

preferred, but males will often spawn with two or more females, hence many operators are using 60-65% females. Sex determination was once a problem for fish farmers. Today, experienced workers approach 100% accuracy in determining sex of brood fish. Male catfish may be distinguished from females by their darker coloration and shorter, wider and more muscular head. The female genitalia is slit-like rather than a tubular, protruding appearance as in the male. As spawning time arrives, mature and well developed males become darkley colored under the jaw and belly region and the genital papillae becomes enlarged. In females, the vent becomes flacid and inflamed and may pulsate when examined. Experienced breeders determine the sex of young or otherwise difficult to sex individuals by probing the genital openings with a blunt instrument such as a dull pencil point. The female will have three openings (anus, genital pore, urinary pore), while the male will have only two openings (anus, urogenital pore). Females in good condition will have distended, soft bellies as spawning approaches.

Spawning receptacles are provided in numerous forms. Milk cans, nail kegs, earthenware crocks, ammunition cans, etc. are successfully used. They are placed in ponds 1-10 yards apart with the open end toward the center of the pond. Each receptacle is marked with a small flat to facilitate easy checks for spawns. Breeders often provide 50-90% as many receptacles as spawning pairs. Most receptacles are placed in water 2-2.5 feet deep. Metal containers are sometimes swabbed inside and out with an asphalt paint to retard rust and corrosion.

As water temperature rises to a constant 74 degrees F. (or greater) spawning will usually begin. Generally, late April or early May brings the onset of spawning season. If the eggs are to be artificially incubated, the receptacles should be checked at three to five days intervals after the water reaches spawning temperature. If the eggs are to be left for the male to hatch, the containers should not be distributed, but the pond should be sprayed with mixture of 2.5 gallons of diesel or kerosene to one quart of motor oil per each surface acre. Spraying should be done during calm weather, as this treatment acts to suffocate predaceous insects that breathe at the water's surface. This treatment should continue every four to six days for six to eight weeks. When checking for eggs, the worker must be aware that the male catfish is very protective of the spawn and the receptacle. He will bite hands and arms that threaten them. If eggs are left in the pond, the operator can usually figure that females that spawn will produce about 2,000 eggs per pound of body weight (a 10 pound female will spawn 20,000 eggs). If spawning frequency seems to lag for no particular reason, it is sometimes effective to lower the water level in the pond a foot or so, then quickly refill the pond in an effort encourage more spawning.

Pen Spawning

Pen spawning is an advancement on pond spawning in that it is more convenient, permits selection of breeding pairs, affords immediate removal of spent females and addition of fresh females as well as treatment of reluctant spawners with hormones to encourage spawning behavior.

Pens are usually constructed along a pond bank with concrete blocks, chain link fencing or other suitable materials. Pens range in size from 3 x 6 feet to 5 x 8 feet. Water depth may range from 2-3.5 feet. The sides of the pen should extend approximately 1-1.5 feet above water level to prevent spawners from leaping out. Each pen is, of course, provided with a receptacle of the same sort as in pond spawning. The selected pair should be carefully observed after being put in the pen as incompatibility will likely lead to dead brood stock. The male fish should be at least as large as the female with which he is paired. If there are excess brood stock, the largest and oldest fish should be paired first as they tend to ripen earliest.

Once spawning has begun, the procedure of pen spawning is the same as for pond spawning except that in the pen method the female is removed as soon after spawning as possible to prevent her from eating the eggs or the male from killing her. Eggs may be removed for artificial incubation or left for the male to hatch. If eggs are removed, a fresh female may be paired with the male after a day or two rest. Males may be used to spawn a number of females if the quality of fertilization remains high.

Aquarium Spawning

Hormone injections are only infrequently used in pen spawning, but in spawning in aquaria, it is essential. This method requires considerable skill and is very capital and labor intensive. On the other hand, very little space is required for actually spawning the fish. Possibly the major advantage to aquarium spawning is that spawning may be synchronized to produce quantities of fry of the same age. It will also minimize the chance of adult predation on fingerlings and reduce the possibility of transmission of disease agents to offspring. Another major advantage is that interspecific hybridization offspring can be produced that have been shown to be superior in terms of ability to gain weight.

Channel catfish respond to a number of fish pituitary extracts as well as human chorionic gonadotropin (HCG) and pregnant mare serum (PMS). After injections (intraperitoneal) with hormones, the fish are paired and placed in aquaria (20-50 gallons) supplied with running water. The pair should be observed closely to determine apparent compatibility. Fish begin spawning after 16-48 hours of most injection series. The eggs are removed upon completion of the

spawn, and a new pair of spawners are injected and put into the tank. Again, this method is probably only feasible or necessary in a research situation.

Egg Incubation and Hatching

Incubation of channel catfish eggs may be done two ways. In the natural method, the male catfish is allowed to do the work of incubation, tending the eggs as soon as the spawn is completely laid. The male guards the eggs and by moving over the mass and by working his fins, circulates water and prevents siltation, suffocation and predation. Natural incubation time varies from 5-10 days depending on water temperature. Although some males can hatch more than one spawn in the same breeding season, artificial incubation seems preferable for two major reasons. First, it gives the male a better chance to spawn more than one female, and, second, it decreases the chance for disease agents to contaminate the eggs.

During artificial incubation, the culturist must provide brooding functions for the eggs to hatch. The eggs are carefully removed from the spawning receptacle and are transported to the hatchery carefully protecting them from strong, direct sunlight. They are placed in paddlewheel troughs (usually about 10 feet long by two feet wide by 10-12 inches deep). Eggs are placed in wire baskets (1/4 inch mesh) and suspended in the troughs. The paddles are driven with an electric motor or water wheel. Rotation of the paddlewheel in the trough ranges from 20-30 rpm. Water flow through the trough varies from one to five gallons per minute. Temperature tolerance for eggs is 70-85°F., but the optimum range is 78-80°F. Artificial incubation at 78-80°F takes about six days. Hatching may last five to six hours but is usually completed in 20-30 minutes. Hatch varies up to 100%. When eggs hatch, the sac fry swim through the hatching basin the trough.

Fungus and bacteria outbreaks sometimes present problems during egg incubation. Growth of fungus on eggs begins on dead organic matter (e.g. infertile eggs). Fungus on eggs appears as white cottony growths made up of many small filaments. Once a fungal colony is established, it is capable of invading and killing healthy eggs and thus destroys the whole egg mass. Treatment of fungal diseases of catfish eggs involves flushing or using a short bath with malachite green or formalin. Malachite green is not registered. A quick dip with malachite at a concentration of about 50 ppm (about 1/4 teaspoon malachite green in 15 gallons of water) has been a common practice to control fungus on eggs. Treatment with this chemical is never used on eyed eggs - only on "green" eggs. Formalin used at 250 ppm for one hour or 1:600 for 15 minutes works well on catfish eggs to control fungus. Currently it is the major chemical approved for control of fungus

on eggs. It is commonly used to treat trout eggs for fungus control.

Bacterial outbreaks can cause very serious destruction of egg masses in a short time. The first indication of a bacterial infection is an opaque or whitish appearance in small areas of the egg mass. This is followed by a general collapse of the jellyatinous matrix supporting the eggs and very often fungus will then invade the eggs. Treatment of eggs for bacterial infections of eggs is a bath or flush. Most prefer an antibiotic bath. Terramycin used at 20 ppm for one hour is successful unless a resistant strain of bacteria is involved. Several nitrofurans (furacin, furanace) are excellent for treating eggs when used one ppm for one hour. Betadine (an iodine compound) when used as a bath at 100 ppm for 15 minutes is also effective.

Cleanliness is the byword in prevention of disease problems in the hatchery. Discard heavily fungused or bacterially infected eggs. After removing fry from a trough, do a thorough job of cleaning it, then fill it with water and add 1000 ppm formalin for one hour. Beginning hatcherymen should learn as much as possible before spawning season, and if problems arise, he should immediately consult with professionals or experienced people in his area.

Water quality in the hatchery is most important. High concentrations of iron, salt, sulfur oxides and organic matter should be avoided at all possible costs. Herbicides and pesticide chemicals in soils as residues (or in water) are extremely hazardous to health eggs. Anyone interested in a hatchery operation should consider having several water samples analyzed and checked by your

local professionals or experienced hatcherymen.

REARING FRY TO FINGERLING OR STOCKER SIZE

Trough Rearing

If eggs have been left to hatch in the pond, the spawners should be removed if possible. After discovery of spawns in a "wild" or pond spawn situation, the surface should be sprayed with a mixture of diesel and motor oil for control of predaceous insects (This will be discussed in a later section). The ponds containing fry should be "oiled" twice a week.

Fry that were incubated artificially should be siphoned from the hatching trough into a container for movement to the rearing or nursing troughs. Newly hatched sac fry will swim to the sides of the hatching troughs where they lie quietly on the bottom and can be easily siphoned out. Deformed or otherwise abnormal fry more often do not associate themselves with the healthy fry. They often are alone or in small irregularly moving groups. These fry should be quickly discarded and not moved with the healthy fry.

Sac fry are moved to rearing troughs where they are released. Usually, rearing troughs are 6-12 feet long, 18-24 inches deep. Most hatcherymen allow a flow of one to five gallons of water per minute through the trough depending on density of young fry.

Newly hatched fry live on the nutrients from the yolk sac for 5-10 days depending on the water temperature. As the yolk sac is absorbed, the fry completely develops mouth parts and a digestive tract and will soon accept food from a variety of sources.

Most hatcherymen begin feeding fry as they begin to "swim-up" seeking food. These "swim up" fry are constantly hungry and should be offered a high quality diet five to six times daily. Feeding should be routinized so that fry are fed at regular intervals. Fry will eat five to eight percent of body weight. Excess feed should be removed. Generally, a feed for "swim-up" fry should be of small size, high in protein (> 36%), high in fats (high energy), and fishy to be palatable to the fry. To obtain the fishery flavor, a high percentage of fish meal in the formula is essential; it should also include fish oil, chopped liver, egg yolk or other ingredients that serve as attractants. It goes without saying that the feed by nutritionally complete. There are several fry feed of good to excellent quality commercially available. After two to four days of feeding in the troughs, fry are transported to the nursery pond for further growth. Sometimes hatcherymen will hold hatched fry for 10-14 days in an effort to stock larger fry in nursery ponds for higher survival.

Preparation of Nursery Ponds

About the time water temperature is suitable for spawning, the nursery ponds should be prepared for receiving fry. There are numerous methods of pond preparation successfully used. Dry ponds can be quickly pumped up and treated, or full ponds can be treated as well. In any case, the ponds should be prepared similarly. First, the pond should be free of all fish. This can be accomplished by draining, or poisoning with any number of fish toxicants. This should be done two to four weeks before fry are to arrive. This is usually followed by inorganic fertilizers (triple superphosphate) to stimulate a "green water" bloom. As a good bloom is established, many farmers add an organic fertilizer in the form of hay, meat and bone meal, tankage, pelleted alfalfa, or other organic material capable of stimulating a good zooplankton bloom about a week before stocking fry. (1-3 bales of hay/acre, or 200-800 lbs. meat and bone meal, tankage or pelleted alfalfa).

About three days prior to stocking, successful hatcherymen apply some sort of control on predaceous insects. Fry ponds are "oiled" with a mixture of 2.5 to 3 gallons of diesel or kerosene plus two quarts of motor oil per acre. The success of the treatment

depends on how well it is spread over the water's surface. It kills insects by suffocation due to the film on the water, so spray the pond during the calmest time of day to get good coverage and a good kill. Oiling of ponds containing fry should be continued for two to three weeks, with applications at four day intervals. Then, 36-48 hours before fry are stocked, the pond should be thoroughly treated with Baytex at one pint per surface acre. Baytex will effectively control any predaceous or otherwise noxious insects which respire through gills.

When fry are ready for transport, they should be moved during the coolest part of the day, preferably early morning or late evening. A thermometer is an important tool in hatchery operation and is very important when stocking fry. Fry should be carefully acclimated into the rearing pond environment. Feeding of fry should begin immediately. A high quality (36-40% protein) feeding the form of small crumbles will make an adequate supplemental diet for fry and small fingerlings. Optimum feed particle sizes for small catfish are as follows:

Fish Size (inches)	Feed Size	Feed Allowance per day % of Fish Weight
Swim up fry	00 crumble	6-10
0.5 - 1.5	No.1 crumble	6
1.5 - 2.5	No.3 crumble	5
1.5 - 6	1/8 in. pellet	4-3

The number of fry stocked in rearing ponds depends on pond acreage and the size of fingerlings desired at the end of the growing season.

Fingerling Production

The number of fingerlings produced per acre of pond depends upon the management practices applied and size of fingerling desired. Most fingerlings are grown in ponds ranging from 1 to 25 acres in size. In ordinary rearing ponds, stocking rates of 100,000-150,000 fish per acre are not unusual. The following table demonstrates the density of fish stocked and the size of fingerlings available at 150 days.

Fry Stocked Per Acre	Size Fingerlings Harvested (inches)
10,000	7-10
30,000	6-8
53,000	5-7
73,000	4-6
95,000	3-5
120,000	3-5
140,000	3-4

Growth of fingerlings is very similar to growth of food fish. The major difference is in the size of fish produced. Fingerlings probably require more expertise and care in production than food fish do. The rates of stocking in the previously mentioned table will require strict, aggressive management and very conscientious feeding programs if quality fingerlings of the desired size are to be harvested.

Feeding Fingerlings

When fingerlings are stocked, they are usually fed two to three times daily (or more) with a high quality, finely ground feed. Most producers try to slightly overfeed young fry as wasted feed produces other fish feeding the form of natural fish food organisms. After about three to four weeks, the small fish will need a larger sized crumble (#3 crumbles) type feed. At five to six weeks of age, most fish are started on very small size pelleted feed. Some farmers prefer sinking feed; some prefer floating feed. Floating feed is more expensive, but allows the hatcherymen to observe the feeding behavior of his fingerlings. To obtain fingerlings of uniform size, always feed enough good quality feed of the proper size. Make sure the particle size of the feed is small enough such that the smallest fish is able to swallow it. After two months of age, fingerlings should be fed at least three percent bodyweight or as much as they will. Keep in mind that water quality can deteriorate when fingerlings are fed more than 35-40 pounds per acre per day. This feeding regime should be followed until fingerlings are harvested.

INTRODUCTION TO COMMERCIAL CATFISH PRODUCTION

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Catfish farming is the leading aquaculture industry in the U.S.A. producing more pounds than all other aquaculture species combined. The largest concentration of catfish acreage is located in the Mississippi River Flood Plain in Mississippi and Arkansas. Over 70,000 acres of commercial catfish ponds are located in this area. With gross revenues exceeding 100 million dollars a year in Mississippi alone.

The reasons for this concentrated industry are several fold. In this Mississippi alluvial there are over 500,000 acres of heavy clay soil well suited for pond construction. There is a good supply of good quality ground water at a depth of 80-120 ft. making pumping economical. There are well established distribution lines for feed and processing in a close proximity. And very importantly, a positive investment climate exists because of the economic success of raising catfish in this area.

Two separate phases of catfish farming can be identified: seed stock production (fingerlings) and grow out. The grow out ponds average 17.5 acres of water, built over a 20 acre block. Fingerling ponds on the other hand average five to seven acres.

The production cycle begins with spawning in May and June. Brood fish, which have been carefully selected, are provided with spawning containers. The eggs are laid in the containers and incubated by the male catfish. They are then collected and moved into a hatchery, where they hatch in three to seven days and are called sac fry. After a few more days they absorb their yolk sac and swim up for food and are called "swim up" fry at this stage. They are then stocked in prepared nursery ponds and grown to about four to six inches in 120-160 days.

The fingerlings are harvested, inventoried and stocked at about 3500-4500/acre in grow out or production ponds. The fish are fed a floating feed every day for 210 days growing season at which time they average 1.25 pounds. The feed conversions average 1.6-1.8 pounds of feed per pound of fish. Water quality, particularly oxygen and nitrite monitoring, is a necessary part of growing catfish. Aeration equipment is also necessary and is used when oxygen concentrations get low. At the end of the grow out phase the ponds are seined and all marketable fish are caught. A large mesh seine (13/8 to 15/8) is used and sub marketable fish are allowed to escape. Stocker sized fish are then introduced (one for each fish removed) to replenish the

stocking rate to the desired number.

The harvesting procedure begins when the fish are crowded into a confined area and the small sub marketable fish are graded out. The small fish when crowded find their way through the net. The marketable catfish are then loaded in a basket, mounted on a boom and loaded into a livehaul truck which is filled with water.

The catfish are transported alive to the processing plant in live haul trucks. The fish arrive at the plant alive and are stunned with electricity. At modern plants, the fish is chilled and packaged within five minutes of being stunned. Rigorous quality controls including volunteer U.S. Department of Commerce inspections are used to insure high quality products. The sales of catfish has increased dramatically in the past few years. For example:

1980	-	46,000,000 lbs.
1981	-	60,000,000 lbs.
1982	-	99,000,000 lbs.
1983	-	137,000,000 lbs.

Reasons for the success in marketing farm raised catfish are several fold. Number one, the product is available 12 months of the year. Secondly, increased product forms, i.e., chillpacked individual quick frozen fillets, steaks, etc. And finally, high quality is maintained by using quality control standards. Additionally, catfish is a very nutritious high quality, mild tasting fish.

AQUACULTURE COMPUTER APPLICATIONS

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Bookstores, magazine racks, libraries and mailboxes are filling up with computer literature. There is a virtual computer hardware, computer software and computer applications information explosion.

Aquaculturists are not immune from this information explosion and more aquaculturists are using this information, buying hardware, buying software and trying to figure out what to do with it. However, there are many struggling with the usual problems of technological adoption and adaptation. There are many that are confused with all the jargon, the conflicting claims, and with the

real value of a machine that produces only words and numbers. There are many that have decided that the computer is not for them.

The last 10 months have witnessed a dramatic change in computer software. This change is significant enough to justify a second and more serious look at the potential application of microcomputers in the aquaculture business. You still have to learn some jargon and develop some new skills, but the benefits of the effort can be significant.

Computer Hardware and Software

Computer hardware includes the printer, the electronic cards, the keyboard, the metal box that holds the disk drives and the cards, and the chips. Computer software is the instructions that tell the computer what to do. Software also helps you communicate with the computer so that you can tell it what to do.

The microcomputer was invented by people who had intimate knowledge of the hardware and could communicate directly with the electronics inside. The early microcomputers and even the early software assumed that you could learn to communicate like these inventors. However, this was not well accepted by people in small business enterprises such as aquaculture. Only the highly motivated aquaculturists or people who had acquired the proper skills from some other experience were willing to sink \$3,000 to \$8,000 into a microcomputer that was difficult to instruct.

During the past 10 months, hundreds of firms have entered the computer software business. The competition is fierce. These firms are trying to satisfy the needs of more and more groups and make their products easier to use. For example, two years ago, if you wanted to use the microcomputer for some basic accounting, you could have bought a software program called the "spreadsheet". You would have read through the manual to find the meaning of each letter on the keyboard and how it make the spreadsheet do certain things. You would have "loaded" the spreadsheet into your computer by inserting a floppy disk. Some blank rows and columns would have appeared on the screen.

Today, you can load a spreadsheet and see some simple instructions on the screen. Choose one of the items on the screen and more instructions appear. When you become confused, hit a special button and the computer tells you what to do next. You can communicate with the computer in plain English.

Today's Software

The most popular software is word processing. You may think that word processing has nothing to do with the aquaculture business. You may think that word processing is only for secretaries.

However, if you think about the number of messages you create and deliver each day, about the many ideas you have and the notes you make, and about the impression you make on people with the written word, you will realize that word processing is one of the most important things you do in the aquaculture business.

Word processing programs allow you to create text on the screen, move text around, change words at random or every place that same word appears, check spelling and even produce text in different languages. Programs such as Wordstar, one of the most popular, also let you store different blocks of text so you can recall and insert them as you wish. Programs such as Multimate, let you juggle words, sentences, or paragraphs around the text until it looks just right. Select allows you to produce text in Spanish as well as English.

Spreadsheet programs increased microcomputer sales more than any other development. The spreadsheet is a blank sheet pictured electronically on your computer monitor. This blank sheet is marked with rows and columns (up to 2048 x 2561) where you can insert numbers, letters or words. Once entered these numbers, letters, or words can be made to interact in hundreds of ways. For example, you may have seven ponds, 15 daily temperature readings on each pond and 45 average fish weight measurements for each pond. These can be listed in their respective rows and columns. With your instructions, the spreadsheet program can calculate means, distributions, significant differences, and even estimate the market value of one degree difference in pond temperature. This arithmetic can be done automatically each time a new temperature and fish weight entry is made. You write the instructions in plain English and algebra.

Visicalc was the first and most popular spreadsheet program. It was followed rapidly by others with major improvements with each new competitor. The Lotus Development Corporation has introduced Symphony which ties the spreadsheet to several other kinds of software. You can call data from electronic storage, call text from your word processing program, put them together in the spreadsheet, perform some calculations and print graphs showing the results. If you can read instructions in English and if you remember your high school algebra, you can be doing all this in just a couple of hours!

Any aquaculturist has files. You store addresses, past sales, invoices, various costs, cash flow projections, technical data on ponds, brood stocks, etc. Your microcomputer can be used as a filing cabinet. You can store on one five inch disk as much as you can cram into that old steel filing cabinet. You can pull up the right file and get to the right information in seconds. You can modify that information and put it back into the file. You can printout a hard copy, or many copies and keep the original information in the file.

If you are not sure where the information is in the file the microcomputer will find it for you. For example, you remember that young man that worked for you and went back to college should be finished about now and might be looking for a job. He was Ralph somebody and his file must be among the 35 old employee forms. The computer will show you all employees that worked for you three to five years ago with the first name of Ralph. It will also show you all those with a first name first letter "R". Then you can visually choose the correct name and call up the name of the College or the old address. One new program Data Base Manager II will even bring up the name based on the sound instead of the spelling.

Some of the most useful new generation software allows you to analyze your operation. Instead of hiring a \$5,000 consultant, you can perform your own objective analysis. You can do a statistical analysis, you can perform a linear programming analysis, you can perform a financial analysis, and you can perform a profit and loss analysis. There are also specialized billing, inventory, job costing, mail labeling, credit analysis, sales analysis and project control programs. Peachtree Software lists 42 specialized programs. Pyramid lists over 50 programs and none of them are computer games!

The newest software is dedicated to making other software easier to use. You can buy software that will teach you how to use your spreadsheet, word processing, and you data base management programs. There is software that divides your screen into smaller screens so that you can see several programs or sets of information simultaneously. There are the specialized computers such as Apple's Lisa and MacIntosh that come with all these user friendly devices built in. For those intimidated by the typewriter keyboard on microcomputers, there is a mouse. The mouse is a small box that you move around the table. This moves a pointer around the screen so you can point to the activity you want.

Your Aquaculture Business

It is mid-morning and you have just finished checking the ponds and given your staff their objectives for the day. You come into the office and pull the papers out of your pocket and put your note pad on the table. You switch on the Microcomputer and insert the operating system. Next you put in your word processing program and transcribe your observations from your note pad and the mornings tour of the ponds. You draft a memo to your accountant to pick up the floppy disk with the weeks expenditures and to prepare an estimate of income taxes due. You draft a memo to your supervisor requesting that he take daily oxygen readings on ponds three and four for the next 10 days.

Next you put in your spreadsheet program, and enter the latest expenses from the

invoices you have in your pocket. You update the column totals and transfer these sums to the cash flow section of the spreadsheet. The cash flow section is automatically adjusted and you see that you are headed for a shortfall next month. You go back to the profit and loss section of your spreadsheet and call up past profit and loss statement from the data base. You write instructions for calculating expense percentages on these old profit and loss statements for the current profit and loss statement. You write another small routine for comparing the current percentages with the historical percentages.

These reveal that utility rates and feed costs are significantly higher than they have been in past years. You call up the data base information on per unit prices on purchased feeds and see that there was big jump in prices just five months ago. You switch to your file manager program and call up the telephone numbers of various feed suppliers. You then switch to your communications program and automatically dial each supplier and ask for feed prices. Back to your data base you discover that utility rates have not increased enough to explain the utility cost increase. The utility data does show a rapid increase in electricity consumption over the past three months. Print this data and add a note to your engineer to check out the efficiency of all the electric motors.

Now you can put "LP88", a linear programming routine into the computer and finish entering the data on pond capacities, pump capacities, storage capacities, etc. After all variable costs, expected production, production and wholesale prices are entered you run the LP and discover that the most important limitation to increased production is the clean water supply. In fact, your LP tells you that a new water supply could add \$35,000 to your profit over the next four years. You go back and run the LP again with very low assumed wholesale prices and still the value of a new water supply is greater than the probable cost.

Buying Software

Investing in microcomputer software or hardware is similar to any other investment decision. However, it is more difficult to measure the potential financial benefits. The computer applications information explosion is helping. It is possible to get accurate and detailed information on how the hardware and software might benefit your business; even an aquaculture business.

With the new generation of software, it will take less time to realize those benefits and there are many new potential benefits that may not be apparent. Visit the computer stores and look at the new literature. Take advantage of training and information programs offered by dealers, community colleges, universities, government agencies, and the software publishers.

PANEL DISCUSSION

Jerry Fortenberry
Spartan Enterprises
South Carolina Catfish Farmers Association

South Carolina Catfish Farmers Association was officially organized in May 1984. The organization consists of fingerling producers, grow-out farmers, processors and others interested in the rapidly growing aquaculture industry.

Although our membership has only grown to 25, the interest in aquaculture is phenomenal! One can hardly pick up a newspaper or magazine today without reading about some aquacultural enterprise. Catfish farming alone has grown from a casual interest or hobby into an industry that exceeds 200 million/year in sales. Mississippi, the largest catfish producer, has over 70,000 acres devoted to catfish production. Construction investment is estimated to be 245 million dollars and directly provides 3,000 jobs, with a direct payroll of 30 million/year.

From January 1982 to January 1983, catfish sales have increased 65%. During January 1983-January 1984, there was an increase of 38% in catfish sales. We want some of that money in South Carolina!

The purpose of our association is to promote and encourage the growth of catfish farming and the many other aspects in South Carolina.

The technology exists. We are blessed with natural resources. We have well qualified personnel and adequate facilities in our universities, U.S. Fish and Wildlife Service and South Carolina Wildlife and Marine Resources Department. With a well organized, cooperative and sincere effort, we can make South Carolina the leader, an example for others to model in developing their own aquaculture industry.

I have been asked to briefly mention some problems facing the development of aquaculture in South Carolina these are addressed below:

1. Resources:

- a. lack of water table maps.
- b. some method of determining availability of ground water accurately; sounding, test wells (inexpensive), etc. needed.
- c. most efficient methods for pumping, heating, cooling, water.
- d. lack of fingerlings.

2. Processing and Marketing:

- a. many growers are unwilling to harvest fish due to labor and seine costs. Processors must be willing to harvest for the small farmer.
- b. we need someone to educate us on various methods of packaging, both fresh (tray packs) and frozen.
- c. there is a need for refrigeration and quick freezing information.
- d. processors need information on "shelf life".
- e. there is a need for a "communication network" to bring potential buyers and sellers together.
- f. we need marketing people to go into the supermarkets, fairs, "mom and pop" grocery stores, etc.; prepare our South Carolina grown products for people to sample.
- g. many small markets already exist for our products. There is a need for some kind of distribution system to supply these small markets.
- h. waste utilization-processing.

3. Research:

- a. we need a more assertive and cooperative effort between private aquaculture and the soil conservation service, the U.S.D.A., University Extension Services, etc.
- b. we need an aquaculture policy statement and development plan. This policy plan and statement would hopefully be a coordinated effort by members of private aquaculture and South Carolina Wildlife and Marine Resources Department; a guideline to tell the world "where we are, how we're going to get there, and how to know when we've arrived."
- c. Restrictions and constraints must be defined and modified where needed, to insure development of coastal wetlands and all other areas conducive to aquaculture. Producers must be allowed and encouraged to sell all farmed products. In return for this right, producers have certain responsibilities. These responsibilities include: repayment for all acquired "public" broodstock; a requirement that all hatcheries maintain "pure stock"; isolation and proper handling of all diseased farm products and proper labeling of all products sold. These are a few of many.

- d. state and national tax dollars must be spent on better enforcement and research. There must be less money spent on fingerling production.

Let us all work together, share our experiences, coordinate our efforts, to insure the growth of South Carolina aquaculture. We need the support of government and government needs our support.

Donna Florio
Consumer Specialist
Seafood Marketing Service Section
Marine Resources Division
South Carolina Wildlife & Marine Resources
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Good afternoon. I am Donna Florio, Consumer Specialist with the South Carolina Wildlife and Marine Resources Department. I work with the Seafood Marketing Program. In response to Jerry Fortenberry, I would like to say that we do perform seafood cooking demonstrations in supermarkets and at festivals; we've recently been at the Crawfish festival, the McClellanville Blessing of the Fleet, and the Charleston Seafood Festival among others. I have not worked with the catfish industry, but we have been working with the crawfish growers and have been involved with them on other projects such as the Carolina Crawfish Marketing Exposition and have produced a crawfish flier. We feel, however, that the industry will have to take the lion's share of responsibility in performing cooking demonstrations. There are only three of us, Will Lacey, the Marketing Specialist; myself and Lois Richter, the Administrative Assistant in our section, and due to time constraints, we are limited in the number of demos we can do. Also, we represent the entire seafood industry in South Carolina, and there are a number of products that need promotion during the year.

I agree with some of the earlier comments I've heard today. As Jack Whetstone said, consumers in this region are not used to eating finger foods, nor are they widely familiar with crawfish, so this marketing effort will need to contain a lot of consumer education and promotion. Cajun culture is being exported, contrary to Ken Roberts' admonitions to the Cajuns--in fact, Paul Prudhomme's Louisiana Kitchen Cookbook is one of the few cookbooks I've seen on the Time Magazine best-seller list for nonfiction. Cajun cooking is the rage and we may as well try and cash in on it, as well as with appetizers and garnishes.

One other problem to overcome is retailing the product. At this point, consumers have to go to the ponds to buy the product, and first they have to find the ponds, which are usually quite rural. To my knowledge, few people are willing to have to pursue such an adventure to buy a food they're barely familiar with. I think you need to work on getting the animals into more retail markets where they are more readily available.

In closing, I would like to say that we are ready and willing to work with you at any time, but are not always able to keep in touch as regular as we'd like. Please call us if you have a problem we can help with, or an idea that you'd like to discuss. We are always happy to hear from you.

Tom Murray
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The Federal Land Bank and Production Credit Association are in business to provide the least cost financing to sound aquaculture operations, just as we are to provide loans to sound row crop, dairy, and other types of more traditional farming operations. Because we are a credit cooperative and generally risk averse, we will strive to be very realistic in our approach to aquaculture. Because these are generally new and developing ventures, initial loans must be made satisfactorily at the outset. Future availability of Farm Credit financing (which is all private capital) could conceivably be limited because of bad experiences at the outset. We will go slowly in developing our aquaculture loans and feel that the borrowers should also go slowly in developing their aquaculture enterprises to avoid any tendency, or temptation, to expand dramatically on borrowed funds at the outset and, through this leveraging, overburden a new and developing operation with debt service. Presently, in South Carolina, we have limited financing in crawfish and catfish operations. We do have some rainbow trout farms in North Carolina, as well as various limited mariculture activities around the four state district.

We generally look at aquaculture loans as any other type of specialized farm loan. In analyzing loans, we consider five basic credit factors: 1) the individual, 2) financial condition, 3) repayment capacity, 4) collateral and 5) Amount, purpose and terms.

In looking at new or developing enterprises such as most aquaculture operations in this state, close attention is paid to each. Weaknesses in one or more of these factors must be offset by strength in one or more of the other factors.

The biggest problem in dealing with financing new and developing aquaculture operations is a lack of a "track record" or repayment capacity verification on the part of applicants. Due to this, a careful review is made of the applicant's financial risk in the new operation, his overall financial condition, history of managing other types of businesses, and the collateral he is willing to pledge to shore up a unproven repayment capacity.

We are just getting our feet wet in this area and we look forward to working with

those present today, both in the industry as well as the university and research community, in developing the information you and we need to effectively analyze the feasibility of these new and promising aquaculture/mariculture operations.

Because of the unique nature of these types of loans, each request is viewed individually and closely for strength in the five credit factors outlined at the outset.

APPENDIX I

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APPENDIX II

ADDITIONAL READING

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